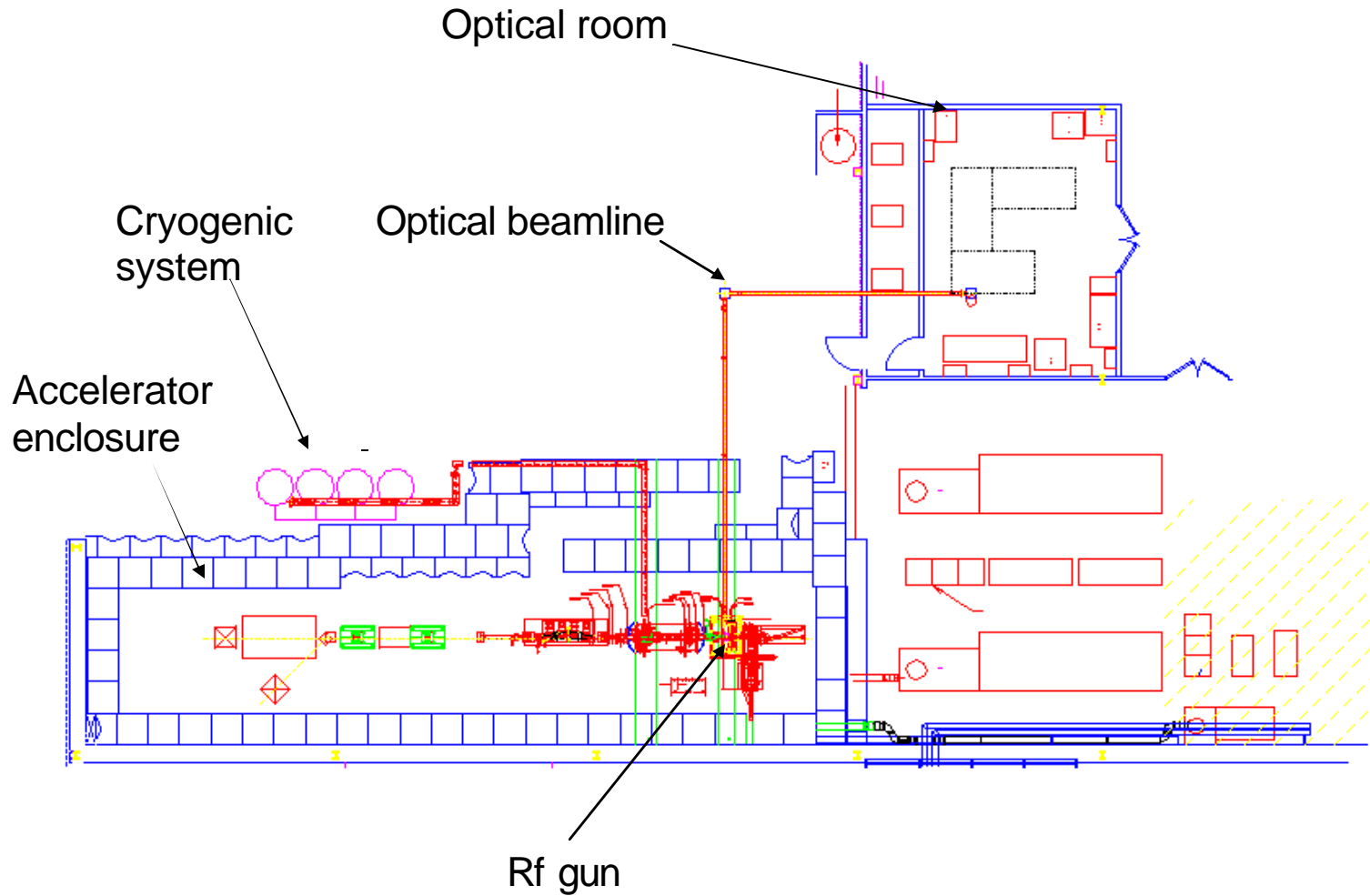


# FNPL control system: an overview

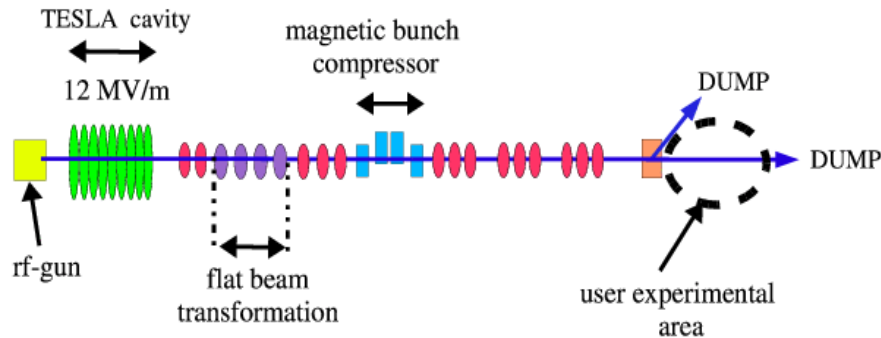
*Philippe PIOT, FNAL*

- Overview of FNPL controls
- System needed to be controlled
- Some personal thoughts

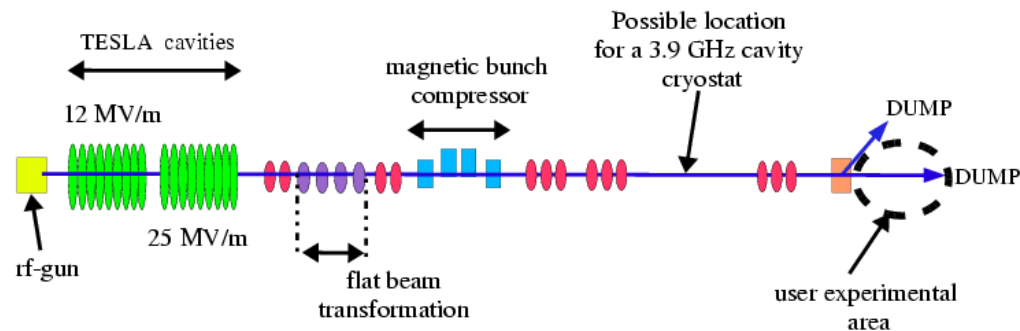
# Present infrastructure at FNPL



# Present and future infrastructure at FNPL

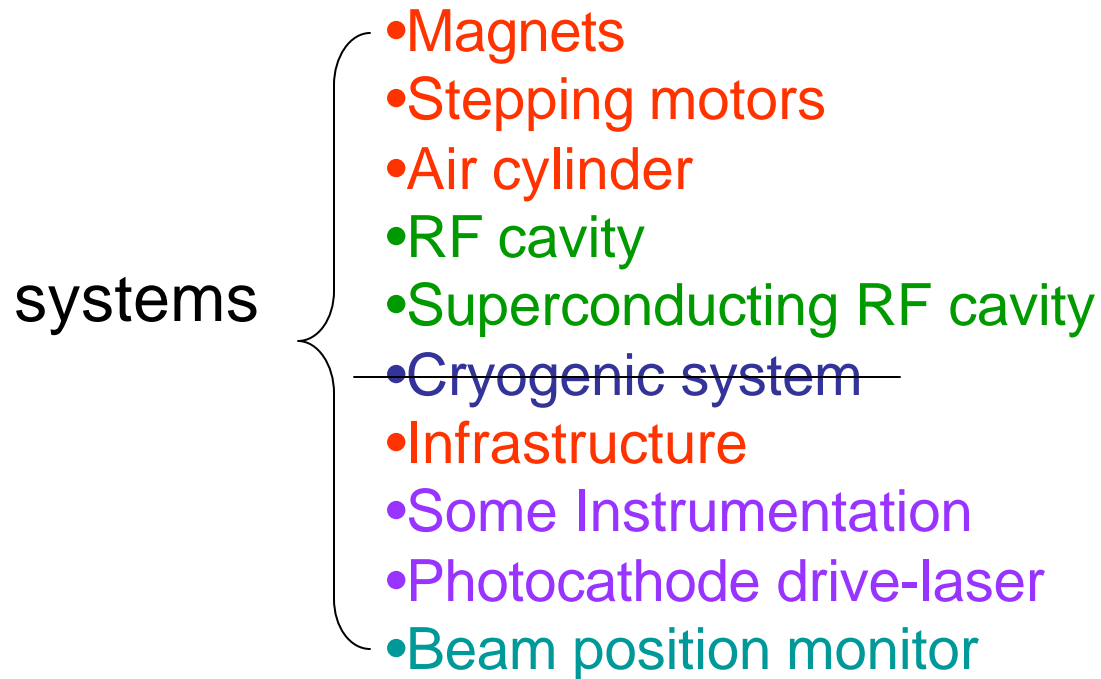


Present layout of the facility



Future layout of the facility: A0 upgrade or SMTF injector A

# Various controls are used at FNPL



IRM + Mac (OS 7!)

DOOCS on Linux and SUN

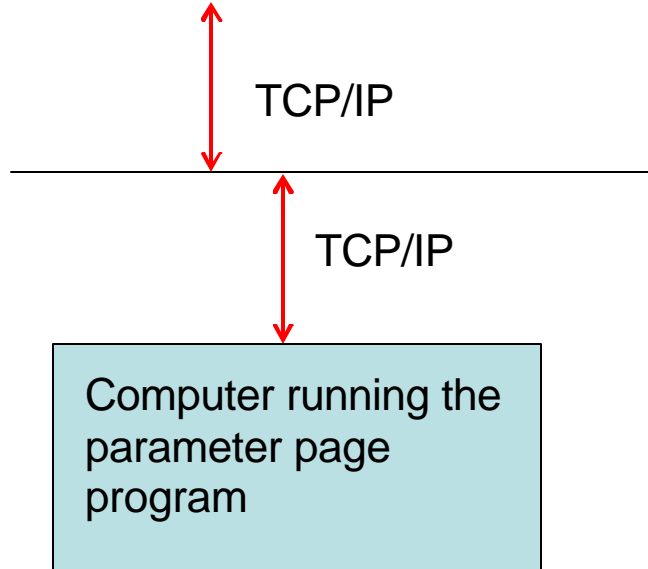
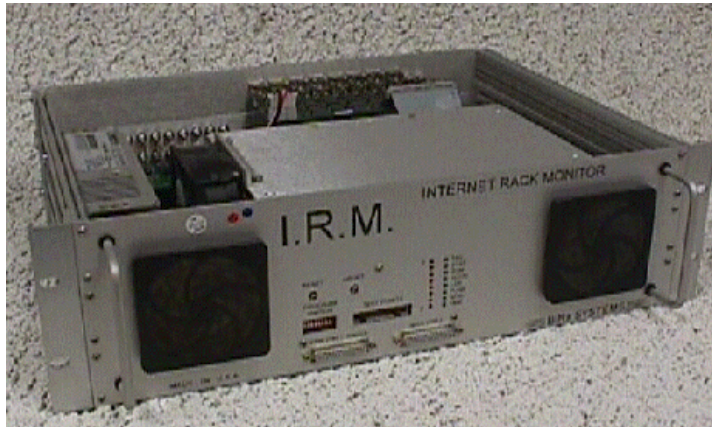
ACNET via X-session from Windows

LabView on standalone Windows PC or Mac

SEDAC system (from DESY/HERA)

controls

# IRM: internal rack monitor



- General purpose data acquisition system based
- Digitizer (digital + analog I/O)
- Based on Motorola MVME-162
- Each IRM is a node on internet
- Used to control magnets, insertion mechanism (air cylinder), stepping motors
- Used to digitized data (current monitor, infrared detector, monitor infrastructure parameter laser room AC, etc)

# IRM: internal rack monitor

- Up to 2002 talked to IRM at FNPL via the parameter page
- Not nice (e.g. variable on DOOCS SUN + parameter to be recorded on IRM)
- Tried to port the C++ library developed at FNAL from SUN OS on Linux -- did not work (Piot/Barov)
- Barov developed a python-based control system
- Python was chosen because (1) it is a multi-platform scripting language and (2) it has the TCP/IP protocol built in
- A python-based parameter page was developed and later a module (“a0controllib”) was written by a summer student (Wennenberg)

# IRM: internal rack monitor

- Now both python and the parameter pages run in parallel

- Python-based toolbox is used to write script to vary variable and measure parameter (e.g. beam based alignment)

From a python script importing the a0 library

```
From a0controlib import *
```

We can access all the functions:

Machine settings save/restore capability:

```
save_config(lat_feb10.sr)
```

```
read_irm(Q1SAX2)
```

```
degauss ('quads')
```

- Problem: this python toolbox was developed for our need by 2/3 people in the group, the 2 largest contributors left the group (a summer student + a postdoc)

# IRM: operator parameter page

Flags_and_Video											
File Channels Display											
SPECT	45DEG SPECTROMETER	1.0	<<	<	>	>>	-0.066	r	A		
CAMCTL	AVMS CNTL	1.0	<<	<	>	>>	0.000	r		... EN	
VIDEO1	A0 VIDEO SWITCH 1	1.0	<<	<	>	>>	16.000	r	VAL		
VIDEO2	A0 VIDEO SWITCH 2	1.0	<<	<	>	>>	7.000	r	VAL		
LITDIM	CAMERA LIGHTDIMMER	1.0	<<	<	>	>>	-2.195	r	V		
FCUPX2	ACT FCUP X02	1.0	<<	<	>	>>	0.000	r		IN ...	
FLAGX2	ACT FLAG X02	1.0	<<	<	>	>>	0.000	r		...OUT	
MOTOR1	X03H IN/OUT	1.0	<<	<	>	>>	4.361	r	MM	OUT	
MOTOR2	X03H ROTATE	1.0	<<	<	>	>>	-23.241	r	DEG	---	
MOTOR3	X03V IN/OUT	1.0	<<	<	>	>>	-10.993	r	MM	OUT	
MOTOR4	X03V ROTATE	1.0	<<	<	>	>>	-273.095	r	DEG	---	
FLAGX4	ACT FLAG X04	1.0	<<	<	>	>>	0.000	r		...OUT	
FLAGX5	ACT FLAG X05	1.0	<<	<	>	>>	0.000	r		...OUT	
MOTOR5	X07H IN/OUT	1.0	<<	<	>	>>	-0.061	r	MM	OUT	
MOTOR6	X07H ROTATE	1.0	<<	<	>	>>	-59.563	r	DEG	---	
MOTOR7	X07V N/OUT	1.0	<<	<	>	>>	0.022	r	MM	OUT	
MOTOR8	X07V ROTATE	1.0	<<	<	>	>>	-17.533	r	DEG	---	
FLAGX6	ACT FLAG X06	1.0	<<	<	>	>>	0.000	r		...OUT	
FLAG08	ACT FLAG X08	1.0	<<	<	>	>>	0.000	r		IN ...	
MIR_X9	X9 FLIPPER	1.0	<<	<	>	>>	0.000	r		...OUT	
FLAGX9	ACT FLAG X09	1.0	<<	<	>	>>	0.000	r		...OUT	
FLAG10	ACT FLAG X10	1.0	<<	<	>	>>	0.000	r		...OUT	
MOTOR9	X11H IN/OUT	1.0	<<	<	>	>>	-24.558	r	MM	OUT	
MOTORA	X11H ROTATE	1.0	<<	<	>	>>	-2851.868	r	DEG	---	
MOTORB	X11V IN/OUT	1.0	<<	<	>	>>	-28.269	r	MM	OUT	
MOTORC	X11V ROTATE	1.0	<<	<	>	>>	8274.842	r	DEG	---	
FLAG12	ACT FLAG X12	1.0	<<	<	>	>>	0.000	r		...OUT	
FLAG13	ACT FLAG X13	1.0	<<	<	>	>>	0.000	r		...OUT	
FLAG14	ACT FLAG X14	1.0	<<	<	>	>>	0.000	r		...OUT	
FLAG15	ACT FLAG X15	1.0	<<	<	>	>>	0.000	r		...OUT	

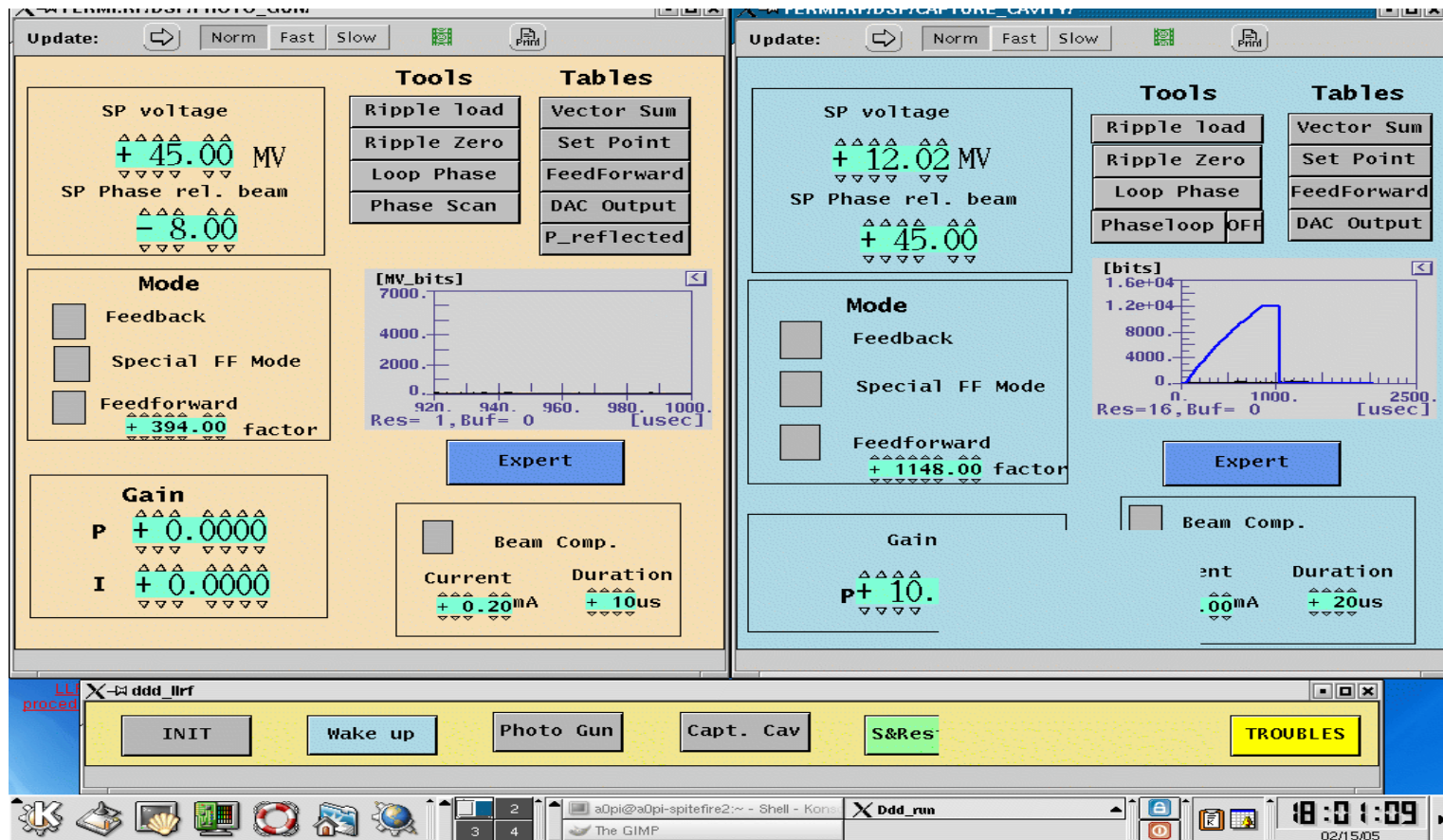


# RF cavities: DOOCS

- RF cavities (both warm rf-gun cavity and TESLA superconducting cavity) are controlled from DOOCS system
- DOOCS: DESY Object Oriented Control System
- DESY delivered the rf-control system with DOOCS as control.
- Low level RF system (DSP) is running on a SUN Sparc 4m (SunOS 5.5!) mounted in a VME crate

# RF cavities DOOCS

- High level (operator windows) is running on a Linux box
- DOOCS has also save/restore capability (to or from files) and this feature is only used for RF parameters)



# DOOCS and outside world

- DOOCS call can be made from ROOT

```
#include <doocs.hh>
V= doocs::get_float("FERMI.RF/DSP/PHOTO_GUN/VECTOR_SUM.AMPL")
```

- DOOCS call can be made from MATLAB, at A0 the library were compiled by Huning to be compatible with OCTAVE which allows development “on the flight” of small application (e.g. slow feedback for RF, measurement of cavity detuning,...)

```
phsp = doocsr([baseaddr, 'SP_PHASE_OFFSET' ] );
doocsw(phsp,[baseaddr, 'SP_PHASE_OFFSET' ] );
```

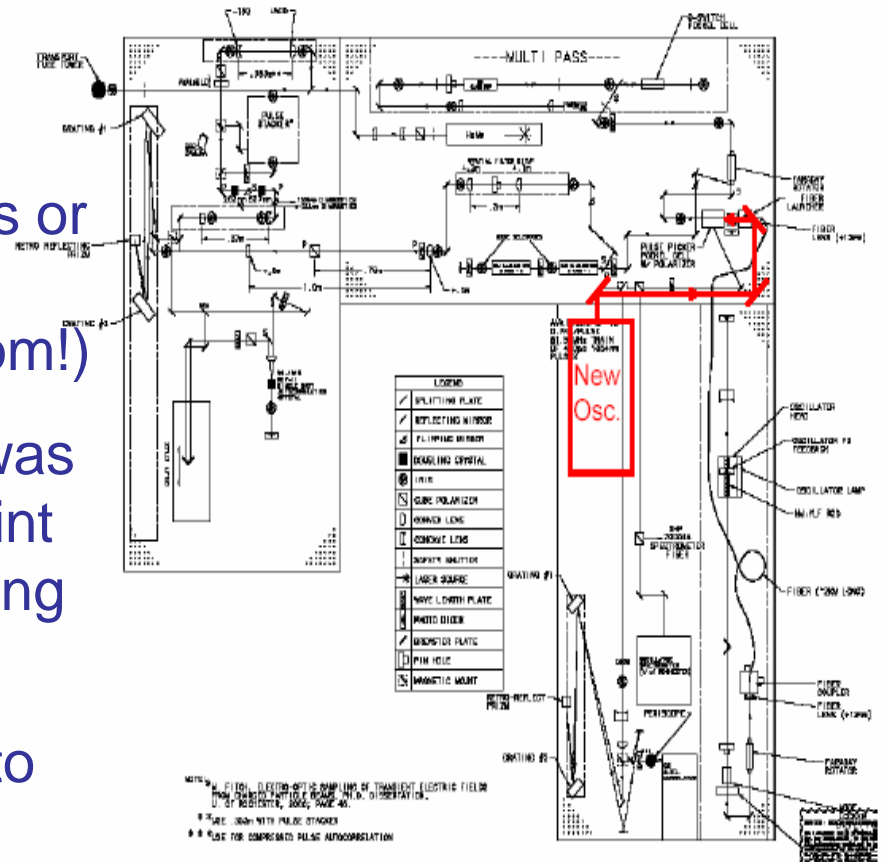
- DOOCS call can be made from Python (Wennenberg), use binaries doocspu and doocsge embeded in python module

```
set_doocs_device('CAPTURE_CAVITY/SP_PHASE_REL_BEAM',str(Phase))
```

- DOOCS variable can now be saved in ACNET (requires a OCTAVE script to be running) thanks to Huning

# photocathode drive-laser

- Photocathode drive laser is a very complicated system
- At the moment no remote control via software (of mirrors or optics) everything on remote control pad (some in laser room!)
- Logging of laser parameter was setup on Labview at some point (J. Li is now working on bringing this logging system up)
- At some point we should try to have piezo motor in control system to minimize people going into laser room



## Class IV laser

# Diagnostics Beam position monitor

- Beam position monitors electronic comes from DESY (copy of HERA system)
- Delivered and installed in ~ 2001, data acquisition used the SEDAC system (electronic directly plug on a WINDOW PC serial port) application used C-basic...
- In 2003, we ported the BPM system on Linux, wrote a C-driver (Wennenberg) + high level python/Blt application for orbit display (slow but OK)

# Diagnostics Beam profile monitor

- Use of YAG or Optical transition radiation screen to measure the beam transverse density (CCD are used to record pictures and digitized)
- Initially Labview was used to display/save beam spots
- Later because of remote operation a video server running under Linux was set-up and image could be displayed in real-time on web pages
- In 2004 we went to digital camera (SONY XCD type) using firewall and IEEE-1394 standard, some applications were developed but are still not reliable we are presently using a public domain application called CORIANDER which is flaky...

# Diagnostics: O-scope

- Some of device are read by O-scope (Lecroy LC574L) only:
  - integrated current transformer (ICT)
  - pyroelectric detector
  - photodiode for UV laser intensity
- The scope is interfaced via GPIB to Labview on Mac
- For some applications we want to get the scope data under linux
- Labview program on Mac broadcasts scope informations on the internet was written and Linux (using ROOT and TCP/IP) can control the scope via this Labview program (not very elegant but works!)

# Special Diagnostics

- Our group uses or develops new diagnostics:
  - coherent radiation-based bunch length measurement,
  - streak camera controls
  - electro-optical imaging soon...
- For this diagnostics we first need (without big effort) fast application to test/debug
- At the moment this is mainly done with Labview (example of Micheleson interferometer, controls developed by Mihalcea of NIU), OCTAVE/MATLAB would be much better...
- To my perception this is not efficient (it takes time to develop Labview program with GPIB and integration in the system does never happen), example Michelson interferometer+ streak camera become standalone system on their own station



# Others

- Vacuum system (apart from few valves) have no interface with the control system (vacuum pressure not available from control room)

- .

- .

# My outsider perspective for a new control system

- ACNET seems user un-friendly (but I know there is effort to port it on linux somewhere at FNAL) it is however nice for logging data over long period of time (cryosystem, infrastructure parameters e.g. temperature of laser room, etc...)
- It seems to me DOOCS / EPICS are the real candidates for a new control system (either and, I hope for A0 upgrade, and for SMTF)

# My outsider perspective ...

- My experience with EPICS (4 years at JLab):
  - MEDM allows fast GUI
  - it is a well polished control system
  - it has many applications that can be obtained from other labs (BESSY, JLAB, BNL, ANL, SNS,...)
  - a lot of accelerator-physics oriented applications have been developed/standardized (essentially at ANL/OAG), e.g. SDDS, SDDSepics toolkits, OAGTcl...
- My experience with DOOCS (3 years at DESY)
  - Not as polished as EPICS (from a user point-of-view)
  - A lot of tools (interfacing with ROOT, LabView, MATLAB gives flexibility even for people that are not control system “gurus”)
  - Even an EPICS interface [(?) used at TTF to control one cavity]

# Summary

- FNPL control system applications was developed/maintained by postdocs, graduate student and summer student, IRM hardware and Mac-based application is the only one supported by control group (M. Kucera et al)
- FNPL control system is poorly documented
- But we now have a system that can run from one operating system and ease experiments
- DOOCS at FNPL has no local maintainer since Huning left
  
- FNPL could be an excellent platform for starting working on control system development for SMTF and it will be beneficial both for FNPL (get some professional involved) and for training of local people
- There are bunch of small projects that could be used as a platform to involve local people, e.g. CTR, digital cameras,...